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THE

TEA QUARTERLY

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TEA RESEARCH INSTITUTE

OF CEYLON

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THE TEA QUARTERLY

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EDITORIAL COMMENT

This number of the *Tea Quarterly* is once more dominated by articles related to replanting of tea by vegetative propagation. This is proper, for the future of the industry will be greatly influenced by the replanting, which is now under way assisted by the subsidy scheme, but is still technically unfamiliar to some planters. Although vegetative propagation has been studied and used by the Institute for two decades, new discoveries about its implications are still being made.

Quality of Made Tea

The first effect of uprooting old tea, rehabilitating the land, and replanting, is a loss of crop. With a regular annual programme of replanting, the tendency to lose production continues until after the first replanting comes into full bearing. It is therefore proper to begin replanting with a very quick-growing and high-yielding clone, to shorten the period of reduced crop and to make the reduction as small as possible. TRI 2024 satisfies these criteria and is also of A1 quality. It is, however, recognized to be unwise for a single clone to predominate in the Island. Once the total crop of an estate begins to rise, therefore, the emphasis is likely to change from weight of yield to a variety of properties in the made tea. Yield can be assessed in rupees instead of in weight. The selection of clones with special manufacturing properties, attracting special prices, will then become of first importance. Mr Keegel's article gives preliminary information on manufacturing properties of made tea of a large number of clones.

It is not easy to get fair data of weight of yield about all these clones. To be comparable, the data must be got in one place over the same period and with great attention to detail. Clonal tests for this purpose have been going on and are being expanded in the various regions. At the moment, the outstanding clones on both yield and quality together seem to be TRI 2024 and the Sirikandura clone S 106.

Approved Clones

The provisional list of clones approved for subsidy has been revised and is printed here. Even though these clones are provisionally approved, they are not all of equal worth, and though some additional ones are likely to be brought in, on the whole the tendency may be towards reduction in the next few years. The 142 clones in the list of March, 1959, are now reduced to 122 clones.

Eelworms

Much work has been done in the last few decades on eelworms parasitising crops in many parts of the world. Inferior crops and crop failures can often be certainly put down to them. Because many parasitic species affect only one or a few species of plants, rotation of crops has tended to check them; but tea is perennial. The replanting of tea in Ceylon offers a rare opportunity of checking a widespread

and sometimes serious pest, by reconditioning the soil. Dr Visser here offers his very last contribution on eelworms and the work has now been taken over by Dr Hutchinson, who is here as a member of the United States Operations Mission. The main point to emphasize is that it is practically impossible to eliminate eelworms from growing tea, so rehabilitation should be used to ensure their elimination from the land, and only clean (as nearly as possible eelworm-free) plants from clean nurseries should be put in. The regulations made under the Plant Protection Ordinance in 1932, prohibiting the movement of tea plants outside an estate, except by permit, were rescinded in 1946 (*see Tea Quarterly*, Vol. 18, page 74); nevertheless, the danger of spreading eelworm is so serious that it is hoped that all planters will voluntarily refuse either to transmit or to receive plants (as distinct from cuttings) across the boundaries of their estates.

Drum Withering

There has been a large rise in tea production in Ceylon since the War and the rise may steepen because of the clonal replanting scheme. The principal problem arising from this is likely to be in accommodation for withering the increased amount of leaf. In many factories, three-quarters of the space is taken up by withering tats and the remaining quarter is not overcrowded with machinery. The crop could be doubled in a couple of decades but increase may be restricted by the expenditure required for doubling the withering accommodation. A method of withering that is more economical of space and money is therefore worthy of study. Mr Hutton's article on drum withering in East Africa, which has been edited and annotated by Mr Keegel for Ceylon conditions, is thus timely. Improvements in the use of the drum make it a possible machine for use in Ceylon, without loss of quality. Indeed, the use of a drier forced draught of cold air might conceivably improve quality.

Magnesium Deficiency

Clonal trials have given crops at least five times as great as the average for the Island and nearly twice the highest commercial yields. Although the detailed applicability of these yields to commercial planting is dubious, there is no doubt that the soil will be called upon to support considerable increases. The more a crop takes out of the soil, the more likely it is to reveal deficiencies in the soil. The more productive a clone is, therefore, the more likely it is to make demands on the soil that are too heavy to be satisfied without special manuring. A deficiency disease of the crop can thus be regarded as a useful direct indicator of what should be done. Dr Mulder and Mr R. L. de Silva have discussed deficiency diseases in general and magnesium deficiency in particular, a disease which is increasing in high-yielding clones and is readily dealt with, once recognized.

Shot-hole-borer Beetle

Although there is no article in this number on shot-hole borer, investigations are proceeding. There is some hope of discovering a strain of tea bush that has some resistance to the borer; even if the original bush were unsatisfactory as a clonal mother, the resistance might be incorporated with other satisfactory qualities by the plant breeder, who is now being sought. At the same time, it is known that it is the best bushes and the best-manured bushes that contain the most borers. The object of this note is to encourage planters to seek resistant bushes. On some estates, a reward of Rs 50/- is offered to a pruner who discovers, in a heavily infested field, a bush that is prolific but not much infested. The Institute is willing to follow up information sent in to the Director about bushes believed to be resistant.

Miscellaneous

The new post of Chief Advisory Officer has been filled by the arrival of Mr C. B. Foster-Barham from Kericho, East Africa, and he is taking over a large part of the advisory work, which has been a heavy load on the specialist research workers. Letters regarding advice should always be addressed impersonally to "The Director" and not to individuals by name. Letters addressed to an individual are often delayed when he is away on tour or on leave, whereas those addressed impersonally to the Director are always opened on the day they arrive and often dealt with more promptly.

Dr Joachim has now taken up his post as Low-Country Adviser again. As Editor, he referred on p. 75 of the current volume of the *Tea Quarterly* to contributions by planters, recording in the *Tea Quarterly* some of their practical observations on new aspects of scientific cultivation of tea. I would go a little further and suggest that a column of "Letters to the Editor," putting questions and points of view as well as factual observations, might be appreciated.

TEA MADE FROM CLONES

E. L. Keegel

Up to the present, in choosing material for vegetative propagation, attention has been concentrated on high yield, good rooting, and other properties connected with the success of the bush, such as resistance to disease and to drought. Many clones with some of these properties are known. It is now time to concentrate on the properties of the tea that can be made from the clones which have been chosen in this way. If a certain clone which has a very high yield, but which does not make a good tea, is widely planted, the estate that uses it may be saddled for half a century with a lot of tea that will be most sensitive to low prices.

These remarks imply that the properties of the made tea depend on the bush. Naturally they depend on weather and manufacture as well—but you can't make a silk purse out of a sow's ear. When the tea is grown and made in the most suitable conditions, if you don't get a good tea then, you never will. The power of providing good tea is inherent in the clone, and some clones will not make into good tea whatever you do to them.

In the past two decades, many hundreds of samples have been made, mostly at St. Coombs by the mincing-machine technique (Keegel, 1953). They have shown clearly that quality is a character inherent in a clone and it is therefore possible to classify the clones according to the type of tea that can be produced from them, as is done in the tables given below.

Logically, there are several conceivable weaknesses in the classification, which depend on the suitability of this technique for the particular clone and for the place where it might be grown. For testing leaf from individual bushes, the mincing-machine technique is the only very small-scale method of manufacture; unfortunately it does not produce quite the same result in made tea from a particular clone as conventional methods do. There is a weakness here, then, in that the small-scale technique may favour or disfavour a particular clone, because that clone has some peculiar properties. We have evidence that this is in fact the case and it seems likely that evidence could be obtained only by a lucky shot, until the biochemistry of the leaf is much better understood. Again, it is *theoretically* possible that a given clone, grown and manufactured in the low-country instead of at St. Coombs, would give better results in made tea. We have no evidence of clones of this type, that would be adapted to low-country conditions in respect of manufacturing properties; the ranking order of clones found for growth and manufacture at St. Coombs seems at present to be the same as for the same clones grown on a low-country estate. It would be rash to ignore the manufacturing tests so far made and to rely on these theoretical possibilities, which are mentioned for the sake of completeness. They will be borne in mind in future researches.

The mincing-machine technique has been carefully standardized at the Institute and it has given reasonably consistent results on quality from particular clones over long periods. Colour and strength have also to be considered; but the technique gives extra colour and strength, which have therefore to be discounted when assessing a clone. The results on quality do, however, inspire confidence.

An alternative method of test, which can be used only when much more leaf from each single clone is available, is the miniature roller (Keegel, 1954). When it can be used, the made teas will correspond much more closely with those made on full-scale rollers.

It has been asked "would the low-country benefit from clonal selection, since all that appears to matter is the appearance of the tea?" The answer is definitely "yes," as the following examples show:—

Sirikandura (altitude 546′ AMSL). Clones S106 and S123, manufactured on the estate on a semi-commercial basis. Tasters' report:—"Appearance and liquors of these teas are far better than any standard yet seen from the low-country. They possess a very rare combination of extremely tippy teas plus bright infusions and liquors."

Ederapolla (altitude 634′ AMSL). Clones from fields 7B, 28 (T.46) and 2A (all three in mixed V.P. material); manufactured on an experimental scale at St. Coombs.

All the samples had a very good black appearance and were very similar—useful Persian Gulf types, exceptionally well made and twisted. The liquors in all cases came out extremely well for low-country tea, being bright with useful colour and strength. The infusion of 7B was exceptionally bright for low-country while 2A had a coppery infusion, more like an up-country tea. One taster described 2A as follows:—"Excellent strength and body combined with brightness, and is as good as if not better than many medium-grown teas."

Here we have cases where proper selection in the low country can not only supply teas that are exceptionally good, but can also satisfy two different markets equally well.

The ability of a clone to reproduce its inherent manufacturing properties when grown in a different environment has also come into question. The two following examples of T.R.I. clones grown in the mid-country and low country will perhaps clear away any doubts that may exist on the advisability of planting a high-grown clone at a lower elevation, as far as its manufacturing properties are concerned.

Gonakelle (Uva). Clones TRI 1294, 1526, 777, 2024 and 1114 were manufactured at St. Coombs on the miniature plant. At the time of manufacture they were only 5 years old and in regular plucking for 3½ years.

Remarkable teas were made except in the case of TRI 1114 which, true to its previous characteristics, gave a coarse tea, much below a typical Uva. The others were very favourably reported on, particularly TRI 1294 which was considered the best of the lot. This and the three others gave strong pungent liquors with nice flavour and quality.

Palmgarden (Ratnapura). Another example of success achieved from T.R.I. clones was the result obtained from the manufacture at St. Coombs of TRI 2023, 2026 and 25 from Palmgarden.

TRI 2026, though not a good quality clone by high-grown standards, yet satisfied the requirements of a low-country tea in all respects. TRI 2023, however, gave a more valuable tea, being more coloury and having almost got quality. TRI 25, because of its quality, could have almost passed as a high-grown tea, but was not black enough in appearance for Middle East markets. All three clones gave brighter infusions and liquors than leaf from a seedling area manufactured at the same time, and in strength and quality were definitely better.

It is not necessary to go into past history of the manufacture tests carried out in the first instance to weed out V.P. material with undesirable characteristics from the point of view of liquoring properties. Rejection was carried out by rigorous standards after numerous tests and the few clones now propagated at St. Coombs are the result. Within the last two years, others have been added with promising physiological characteristics and the present position (30.10.59) is summarised in Tables 3 and 4 at the end of this article.

Considering the limitations of the mincing-machine technique and errors in sampling and tasting, we cannot with any scientific accuracy classify clones in a linear order. However, the classification is a guide for selection purposes.

Recently an attempt was made to have clonal samples, made by the mincing machine technique, reported on in a more elaborate way than hitherto and even valued, each characteristic being assessed on a basis of marks as in Table 1.

TABLE 1.—*Relations between verbal descriptions and marks allotted*

MARKS	INFUSED LEAF	COLOUR	STRENGTH	QUALITY OR CHARACTER	FLAVOUR
0— 2	very dull	very light	very thin	plain	nil
3— 4	dull	light	thin	little	little
5— 6	fair colour	fair	fair	fair	fair
7— 8	bright	coloury	useful	good	useful
9—10	very bright	very coloury	very strong	very good	very marked

As a result some useful data have been collected. Differences in valuation between TRI 2024 and some blister-resistant clones examined on these lines are given in Table 2. These differences might not apply to liquors made by normal methods. Nevertheless they do show up the considerable variation in values of different clones. At the same time the figures reveal the outstanding potential value of TRI 2024.

TABLE 2.—*Difference in valuation between various clones (TRI 2024 is taken as the standard in each case)*

GROUP	CLONE	DIFFERENCE IN VALUATION IN CENTS
A1	W 14	Minus 8
	W 3	,, 20
	S 106	,, 50
A2	D	,, 50
	RL/E	,, 55
	OK 4	,, 60
B	KEW 14/1	,, 50
	KEN 15/8	,, 65
	KEN 15/13	,, 72
	TRI 2114	,, 75
	KEN 22/1	,, 76
	TRI 2091	,, 80
	TRI 2042	,, 88
	KEN 13/3	,, 90
	TRI 2086	,, 95
C	OK 1	,, 85
	TRI 2115	,, 90
	TRI 2065	,, 100
	KEN 16/3	,, 108
	KEN 15/2	,, 150

These figures show what can be achieved by clonal selection.

There are doubtless carefully selected clones on various estates that are not considered in this article. Some of these may turn out to be more useful than those selected at the Institute, but we cannot comment on them until trial manufactures have been done.

In conclusion we gratefully acknowledge the invaluable help of tasters in Colombo and London, and in particular we wish to mention Messrs T. Kane and A. J. Pelly-Fry, and the late Mr R. H. Horne, all of whom have given unstinted assistance in the tasting of a large number of clonal samples.

Abbreviations used in the following tables

TRI	...	Tea Research Institute	KM	...	Kirimetiya
B	...	Bogawana	KPW	...	Kanapediwatte
C	...	Chapelton	M	...	Mooloya
CH	...	Craighead	MH	...	Moray
D (DN)	...	Diyagama	N	...	Nayabedde
DA	...	Dambatenne	OK	...	Ouvahkellie
DK	...	Diyanilakele	RL	...	Rutland
DT	...	Drayton	S	...	Sirikandura
GL	...	Glasgow	TK	...	Talankande
K	...	Kirkoswald	UR	...	Uda Radella
KEN	...	Kenilworth	VK	...	*Vellikelle
KEW	...	Kew	W	...	Wootton

* One of the divisions of Ouvahkellie

The following lists are subject to revision as more information becomes available on manufacturing characteristics. The clones are *not* arranged according to merit within each list.

The clones in Group A1 are all so outstanding with respect to quality that yield is not of great significance. In Group A2 it would be advisable to take yield into account as well. Some of the clones in this group might well be ranked as A1, but they are grouped under A2 until more evidence is available. For example TRI 331, TRI 2142, TRI 2145, GL 48, DK 8, DK 16, DT 95, and K 150, appear very promising. There may be others which would, after further testing, prove to be excellent. Clones in Group B are of average quality and may be considered for propagation in the light of yield, special manufacturing properties, and any other features such as resistance to drought, disease, etc. As for those in Group C, none can be recommended. However, in view of the fact that clone TRI 2026 has been found to thrive in the low-country, it is proposed to re-examine the manufacturing properties of this clone in relation to low-country requirements. Another clone which also requires further study is TRI 1114, in view of its very high potential yield. From the evidence available so far it has not produced a sufficiently attractive tea to justify its use in replanting.

TABLE 3.—*Classification of clones into groups according to quality.*

Group A1—*Clones of good quality*

Clone No.	*Special Features*
TRI 777	Very attractive tea
TRI 1294	Pungent liquor with a very bright greenish infusion
TRI 1526	Harsh liquor, otherwise outstanding
TRI 2024	Very useful all-rounder
DK 19	Very useful clone
DT 1	Excellent clone with a very bright coppery infusion
S 106	Coppery infusion and creams down well
W 3	Useful strength and colour
W 14	Nice quality. Attractive clone

Group A2—Clones with very fair quality

Clone No.	*Special Features*
TRI 4	
TRI 14	
TRI 15	
TRI 16	
TRI 21	Fairly good all-rounder
TRI 23	Rather light
TRI 25	Rather light
TRI 37	Very rapid fermenter
TRI 43	A fairly good all-rounder
TRI 45	A fairly good all-rounder
TRI 46	A fast fermenter. Very good coppery infusion
TRI 128	A good all-round tea
TRI 216	All-round tea
TRI 222	
TRI 331	Very bright coppery infusion
TRI 425	Good tea
TRI 483	Useful colour and quality
TRI 769	Coloury and strong
TRI 784	Very good fermenter
TRI 928	Fairly good all-rounder
TRI 1002	Good all-rounder
TRI 1005	If not for greenish character, a good tea
TRI 1016	Good all-rounder
TRI 1076	A little green
TRI 1082	Mellow smooth liquor
TRI 1456	Fairly good all-rounder
TRI 1530	Round and useful liquor
TRI 2020	Liquor slightly greenish, otherwise useful quality
TRI 2021	Useful tea
TRI 2023	Fairly good all-rounder
TRI 2041	Bright coppery infusion
TRI 2116	Coloury liquor
TRI 2142	Bright coppery infusion
TRI 2145	Bright coppery infusion
TRI 2151	Useful clone
C 171	Fairly good all-rounder
D	Greenish dull infusion
DK 8	Bright infusion
DK 16	Useful all-rounder
DT 95	Useful clone
GL 48	A fairly good all-rounder
K 150	Useful all-rounder
KEN 15/7	Useful colour and strength
MH	Coppery infusion
N 3	Good, bright infusion
OK 4	Useful strength
RL/E	Greenish infusion but coloury liquor
S 123	Attractive coloured infusion. Coloury
TK 48	Poor fermenter, somewhat green liquor
UR 12	Bright infusion, useful strength and coloury
VK 9	Rather greenish but useful strength

Group B—Clones with fair quality

Clone No.	*Special Features*
TRI 1	
TRI 19	
TRI 32	Rapid fermenter. Very coloury
TRI 33	Slow fermenter but bright greenish infusion
TRI 34	Rather greenish
TRI 170	A fairly good all-rounder
TRI 235	Rather light
TRI 293	Greenish liquor
TRI 343	A fair all-rounder
TRI 397	Rather greenish
TRI 603	Fair all-rounder
TRI 679	Fair all-rounder
TRI 839	Rather light and greenish
TRI 862	Fair all-rounder
TRI 934	
TRI 999	Fair all-rounder
TRI 1000	Fair all-rounder
TRI 1001	Fair all-rounder
TRI 1114	Slightly harsh liquor. Poor fermenter
TRI 1128	Fair all-rounder
TRI 2016	Fair all-rounder
TRI 2022	Little greenish
TRI 2025	Coloury
TRI 2042	Fair all-rounder
TRI 2086	Fair all-rounder
TRI 2091	Useful strength
TRI 2114	Fair all-rounder
B 95	Fair all-rounder
CH 13	Bright infusion
DA 434	Average tea
DK 1	Greenish infusion
DN	Greenish infusion
KEN 13/3	Useful strength
KEN 15/8	Fair all-rounder
KEN 15/13	Fair all-rounder
KEN 22/1	Good strength and colour
KEW 4A/2	Fair all-rounder
KEW 4A/4	Fair all-rounder
KEW 14/1	Rather greenish
KM 247	Fair all-rounder
M 21	Coppery infusion
OK 2	Fair all-rounder
OK 3	Fair all-rounder
TK 42	Rather greenish
VK 1	Not a bright infusion. Useful colour

Group C—Clones with little quality

Clone No.	*Special Features*
TRI 9	Non-fermenter
TRI 13	Not up to standard
TRI 18	Rather dull and plain
TRI 20	Dullish and plain
TRI 22	Rather plain and greenish

Clone No.	*Special Features*
TRI 26	Very poor tea but excellent colour
TRI 105	Not up to average standard
TRI 142	Poor tea
TRI 223	Good strength but not sufficient quality
TRI 384	Plain
TRI 396	Greenish
TRI 407	Plain with a fruity odour
TRI 510	Inclined to be soft
TRI 708	Very thin
TRI 740	Greenish
TRI 742	Very thin
TRI 789	Unattractive harsh liquor
TRI 896	Greenish
TRI 946	Green and thin
TRI 960	Coloury but poor quality
TRI 997	Not up to average standard
TRI 1054	Not up to average standard
TRI 1118	Not up to average standard
TRI 1387	Some colour but not sufficient quality
TRI 1446	Greenish
TRI 1544	Strong but little quality
TRI 2026	Dull and coloury
TRI 2043	Very coloury but lacks strength
TRI 2046	Coloury
TRI 2065	Dull infusion
TRI 2104	Dull infusion
TRI 2115	Not up to average standard
TRI 2118	Not up to average standard
TRI 2135	Not up to average standard
DK 11	Unattractive
DT 150	Dull greenish infusion
K 145	Rather green and plain. Good colour
KEN 15/2	Not up to average standard
KEN 16/3	Useful colour but below average quality
KPW Seedling	Very green, rather dull liquor
M 3	Dull greenish infusion
OK 1	Not up to average standard

TABLE 4.—*List of clones, grown on different estates and tested at the Institute, which appear promising as regards quality*

Estate	*Clone*	*Special Features*
Balangoda	13	Coloury
Balmoral	CD2	Useful colour and strength
Calsay	2	Quite useful quality, but rather greenish
	11	Smooth liquor
	1	Very coloury with a smooth liquor
Carolina	2/18	Stand-out all-round tea with bright coppery infusion
Chapelton	7	Bright even red infusion. Nice quality
	68	Good all-rounder
Concordia	34	Fair all-rounder
Court Lodge	31	Fair all-rounder
	32	Bright coppery infusion. Nice quality combined with good strength and some pungency
	25	Fairly useful

Estate	*Clone*	*Special Features*
Dickoya (Dunbar)	5/3	Coloury, but not particularly strong
	4/4	Coloury, but not particularly strong
Diyagama	G	Coloury
	13	Good all-rounder
	21	Good all-rounder
	F	Good colour and quality
Drayton	1	Good all-rounder
	95	Good all-rounder
Eltoft	L17	Particularly good quality
Glentilt	7/1	A most suitable clone. Very good strength and useful quality
Hellbodde	16/19	Coloury
	16/14	Strong pungent liquor
	16/13	Strong pungent liquor
	13/4	Strong pungent liquor
	6A/1	Outstanding, thick, coloury rich liquor; very bright coppery infusion
	6A/2	Very useful tea
	6A/3	Very useful tea
Kirkoswald	136	Fair all-rounder
Loolecondera	LC1	Attractive quality but light liquor
	LC50	Good all-rounder
Melfort	S/4/10	Exceptional all-rounder
	S/4/37	Good all-rounder
	S/4/40	Stand-out quality
Nayabedde	9	Good all-rounder
Nayapane	RF4	Good all-rounder
	6/20	Attractive liquor
	7/4	Good all-rounder
	6/19	Very attractive liquor with a very bright infusion
Neluwa	48 2/4	Fair all-rounder
	48 2/11	Fair all-rounder
Ouvahkellie	OK4	An example of a good class of Dimbula tea. Attractive liquor with fullness and roundness
Park	2202	Useful but greenish in character
	1703	Useful and has some flavour
Pitakande	SW10	Useful strength and colour
	SW11	Useful strength and colour
Portmore & Aldourie	7/3	Useful clone
	7/4	Useful clone
Queenstown	3/3	Good all-rounder
	3/4	Good all-rounder
Rayigam	RGM/12	Very good all-round tea
Sheen	LPS/3	Nice smooth tea with a good red infusion but fair colour
Sirikandura	S106	Good creaming qualities
	S123	Infused leaf up to good high-grown standard and above general average
Stellenburg	16	A little light otherwise fairly good quality
Stonycliff	11	Rather light but good quality
Talankande	42	Useful all-rounder
	36	Quite attractive
Thotulagalla	5/35	Rather light but attractive

References

KEEGEL, E. L. (1953). Vegetative propagation of tea — the manufacturing aspect. *Tea Quart.*, **24**: 82–89.

KEEGEL, E. L. (1954). A note on the operation of the miniature roller. *Tea Quart.*, **25**: 66–67.

REVISED PROVISIONAL LIST OF APPROVED CLONES

Approved on the basis of records available at the Tea Research Institute and the Tea Control Department. Revised December, 1959, and cancelling the list published in *Tea Quarterly*, Vol. 30, Part 1, March, 1959, page 52.

Tea Research Institute: (St. Coombs Estate, Talawakele)	Clone Nos:	TRI 23, 25, 740, 777, 1076, 1114, 1294, 1526, 2016, 2020, 2021, 2022, 2023, 2024, 2025, 2026.
Agra Ouvah:	,, ,,	A/O.
Balangoda Group:	,, ,,	MT12, MT13, MT16, MT17, MT18, MT20, DG3, DG7, DG39, DG43, DG51, DG52, DG54, DG56, DG58, DG66, DG67.
Cannaverella Group:	,, ,,	CV4/B1, CV5/B1, MG3/B1, NK4/B29.
Carolina Group:	,, ,,	2/18, 3/1, 6/3, 7/3, 7/10.
Chapelton Estate:	,, ,,	C171.
Craighead Estate:	,, ,,	CH13.
Diyagama West Estate:	,, ,,	A, B, C, D, DI, DN, E, G, K, N, P, 1, 2, 3, 4, 6, 7, 12, 13, 15, 19, 21, 22, 27.
Drayton Estate	,, ,,	DT1, DT95.
Fernlands Estate:	,, ,,	F4, F8.
Hellbodde Estate:	,, ,,	16/13, 16/14, 16/19, 13/4, 2A/1.
Hunnasgeria Estate:	,, ,,	No. 1, No. 5.
Kenilworth Estate:	,, ,,	13/3, 15/2, 15/7, 15/8, 15/13, 16/3, 22/1.
Kirkoswald Estate:	,, ,,	K145, K150.
Kolapatane Estate:	,, ,,	1/8, 82/7B.
Moray Estate:	,, ,,	MG, MH.
Nayabedde Estate:	,, ,,	Nay-3.
Neluwa Estate:	,, ,,	NL 3/1, NL 4/2, NL 8/3.
Niriella Estate:	,, ,,	1B7, 3B22, 3B30, 12B30.
Pindenioya Estate:	,, ,,	PO5.
Pitakande Estate:	,, ,,	S.W.11.
Queenstown Estate:	,, ,,	QT 1/3, QT 1/5, QT 2/3, QT 2/5, QT 3/4, QT 4/4, QT 7/1.
Rutland Estate:	,, ,,	RL.A. RL.E.
Sirikandura Estate:	,, ,,	S106, S123.
Talankande Estate:	,, ,,	TK42, TK45, TK48.
Tangakelle Estate:	,, ,,	CY 9.
Tillicoultry Estate:	,, ,,	No. 9.
Uda Radella Estate:	,, ,,	UR12.
Uva Highlands Estate:	,, ,,	UH 3/4, UH 9/3.

It will be noted that the following changes have been made in the list published in the *Tea Quarterly*, Vol. 30, page 52:—

Instead of Diyagama Group, Diyagama West Estate is specified for the Diyagama clones.

The following clones have been deleted, mainly because they are not available: Bogawana, B8, B95; Kew, 4A2, 4A4, 14/1; Kirkoswald, K136; Niriella, 3B39; Ottery, OT5/8, OT5/18, OT5/30, 6A/35, 1B/3; Ouvahkellie, OK1, OK2, OK3, OK4, VK1, VK9; Wootton, W3, W14.

Further revisions will be made from time to time.

PRACTICAL ASPECTS OF THE EELWORM PROBLEM IN TEA

T. Visser

Introduction

Infestation of tea by parasitic eelworms has been investigated by the Institute for many years and has been referred to in numerous articles (reviewed by Visser, 1959); but the eelworm problem is still with us and, because subsidised replanting of eelworm-infested fields is being undertaken, we draw attention once more to some features of practical importance.

Among the eelworms which attack both young and mature tea, the meadow eelworm (*Pratylenchus coffeae* Sher & Allen) is the most damaging. Root-knot eelworm (*Meloidogyne javanica* Chitwood) infests young tea plants (in India: *M. incognita* Chitwood), but does not appear to attack mature tea. Another species of the same genus (*M. brevicauda* Loos) has been reported to do severe damage to mature bushes, but so far in only a few isolated cases. How far other eelworms infest and harm tea in Ceylon is not yet known, but Dr Hutchinson is investigating this.

It is not surprising that parasitic eelworms have appeared as a pest, for this is a common occurrence in any crop, whether annual or perennial, if it is grown continuously in the same place. Under such conditions, a slow increase in the eelworm population is to be expected, though adverse effects on the crop vary in severity.

The information available indicates that meadow-eelworm infestation is fairly widespread in the Dimbula district, that it is prevalent in certain areas of other districts as well, and that it has become a serious and acute pest on only a few estates. It cannot be said for certain whether infestation at present latent is going to become apparent and increasingly severe with increasing age of the tea or whether it can be kept in check indefinitely. Presumably, there are factors which decide whether or not eelworm infestation will become serious, for one can find fields or estates, side by side, of which the one is much less infested than the other, judging by the appearance of the bushes and by their yield.

There is no doubt that estates where meadow-eelworm infestation is acute have a serious problem. Losses in yield of heavily infested fields may be about 250 lb. of made tea per acre per year, as compared with fields with little or no infestation.

Bush and Soil Management

There is something to be said for the school of thought which claims that the eelworm problem in Ceylon is partly an agricultural problem related to the condition of both bush and soil. It is evident that weak bushes are more easily affected by adverse conditions than healthy ones, though it must be remembered that it is the best-manured and most productive tea bush that tends to contain most shot-hole-borer beetles.

In general, however, all factors like erosion, hard plucking, hard pruning and insufficient manuring, which tend to weaken the bush, are also liable to aggravate

the effects of eelworm attack. This is confirmed by observations in the field and the weaker bush succumbs sooner than the stronger.

Since the eelworm destroys the feeding roots, the speed with which the roots can be replaced affects the chances of survival of the bush. For instance, when any bush is pruned, many of its feeding roots normally die. New ones will subsequently be formed, the capacity for growth largely depending on the condition of the bush before pruning. If the reserves are low, subsequent recovery will be slow. Consequently, eelworm attack on the few, slowly forming, feeding roots at this time may lead to the degeneration or death of the bush. It is possible, moreover, that roots of weakened bushes are more readily attacked by eelworms than those of vigorous ones.

The health of the bush is naturally affected not only by the treatment given to it as regards plucking and pruning, but also by the condition and fertility of the soil in which it grows. Bushes in soils with maintained or augmented organic matter content are likely to grow more vigorously and thus will be less prone to eelworm damage than bushes whose growth is impeded by low soil fertility.

In addition to this, there are indications that the application of organic material to the soil may have a direct depressing effect on the parasitic eelworm population, in so far as it probably increases the resistance of the roots to eelworm attack. It may well be that the gradual destruction of the organic matter and disappearance of the top soil caused by erosion and exposure—as a result of bad agricultural practices—have increased the severity of eelworm infestation on certain old tea plantations.

The application of organic material, in the form of thatch, compost, stable manure or loppings, is therefore sound agricultural practice, not only for improving soil conditions but also for keeping eelworm infestation in check. In short, all measures normally aimed at increasing the yield and the maintenance of soil fertility should also help to check or slow down the degeneration of old tea through eelworm infestation. The emphasis must be on *prevention*, for the bushes cannot be cured once they begin to show symptoms of eelworm attack.

Green Manures and Shade Trees

The growing of green manures (cover crops) in the tea is obviously of benefit to the soil. They sometimes serve a double purpose; for example, *dadaps* (*Erithryna lithosperma*) and *Gliricidias* provide both shade and loppings. The same is true of shade trees proper like *Grevillea* or *Albizzia* where leaf-fall adds to the organic matter supply. Naturally both the organic matter provided by their roots and the competition of those roots should also be taken into account.

Cover crops in the strict sense are only sporadically grown in tea, partly because they do not grow well under a good cover of tea and partly because their cultivation is not encouraged for fear of competition and the difficulty of their eradication. Nevertheless there are some estates which now practise clean weeding, but might well profit from a cover crop against exposure to soil erosion and other climatic influences, particularly after pruning.

Naturally it is important to know if a plant species is susceptible to the same eelworm species that attack mature tea bushes and it is inadvisable to use susceptible species. The available data concerning the susceptibility of a number of cover crops, bush crops and shade trees have been reviewed previously (Visser, 1959, 1959*a*), so only a brief summary is given here.

All of the cover crops and weeds investigated appeared to be nearly or completely resistant to meadow-eelworm attack. Of these, four grass species, notably Guatemala grass, are resistant to root-knot eelworm as well. As for bush crops,

the planting of *Tephrosia vogelii* is not recommended because it is susceptible to both meadow eelworm and root-knot eelworm; most *Crotalaria* species, on the other hand, are remarkably immune to both eelworms. Among shade trees commonly grown in tea, only *dadap* shows such a susceptibility to root-knot eelworm that degeneration may often occur; *Albizzia sumatrana*, though attacked by the same eelworm, does not seem to suffer from it. Some other shade trees were found to be not susceptible, or only slightly so, to either meadow or root-knot eelworms.

Accordingly, it may be said that most of the plants investigated so far do not appear to be congenial hosts for meadow eelworm and therefore are not likely to contribute to its spread: the exception is *Tephrosia vogelii*, which ought not to be used. The susceptibility of some of them to root-knot eelworm is a handicap only during their own establishment, but this species will not endanger mature tea. It is very important, however, not to grow susceptible plants in nurseries that may be used later for the propagation of tea, because young tea plants are susceptible to root-knot eelworm.

In this context attention must be drawn to marigolds (*Tagetes patula* and *T. erecta* varieties); these species have been shown to have a very marked suppressing effect on both meadow and root-knot eelworms (Visser & Vythilingam, 1959). In fact the cultivation of marigolds has been found to be as effective as fumigation. In our trials we obtained the best results with two vigorously growing types which were obtained locally. Both, sown in rows 9–12″ apart, were found to grow extremely well on fallow tea soil (when liberally manured) and they provided a great amount of organic material, estimated at 15 to 20 tons fresh weight per acre, within 5 to 7 months after sowing. These varieties almost completely covered the soil 2½ months after sowing, while, once fully established, they appeared effectively to suppress weed growth, forming both a dense cover (4–5 ft. high) and a continuous mat of roots.

Marigolds as a cover crop in *young tea*, sown immediately after the plants were put out, did equally well, but competed rather severely with the young tea plants. In *mature tea* they grew only moderately well when sown after pruning and then only in fields with many vacancies and when left undisturbed for several months. Although in both cases the meadow-eelworm population was significantly depressed, the cultivation of marigolds, on their own or together with another cover crop, is successful and practical only in the absence of tea.

Fumigation

Fumigation of mature tea can be carried out without phytotoxic effects to the bushes with Nemagon at 10 gallons per acre (Loos, 1953, 1954, 1956; Visser, 1959*a*). Although reinfestation of the soil is likely to occur after some time, probably on a small scale within a year, the effect on the bushes has been observed to be favourable. Indications are that in the year following fumigation (done after pruning) a 25% increase in yield may be obtainable (Visser, 1959). Yield increases may continue longer than a year. Unfortunately fumigation of old infested tea is not economically worth while at present, costing about Rs. 800/- per acre.

Fumigation of nurseries and soil used for basket plants, on the other hand, is a practice which can be, and should be, a *standard procedure* when eelworms are present. It costs only a fraction of the value of young plants succumbing to moderate eelworm attack in the nursery or after transfer to the field. It must be remembered, however, that it is of little use to fumigate nurseries that *already* carry infested young tea plants. Shell D.D. and Nematox are very toxic to young plants, while Nemagon — though not phytotoxic — is not very effective in killing the eelworms living in the roots.

Regarding nursery soils, care should be taken *not* to use a nursery that is already heavily infested or worn out (Visser, 1958; Visser, Kehl and Tillekeratne, 1959). Such a nursery should be abandoned, or its soil should be reconditioned or replaced by new soil. The use of "tea soil" should be avoided for, apart from possible infestation with parasitic eelworms, it is not the best medium for either propagation or basket plants. Moreover, such soil is likely to contain roots which, if infested, are not so easily rendered harmless by fumigation. Instead, soil from Guatemala grass areas, or good *patana*, or jungle soil should be used; the meadow and root-knot eelworm populations in such soils are usually low; rooting and growth are better in grass soils than in tea soil.

A satisfactory substitute, when grass soils are not available, can be made up by mixing sub-soil, peat litter and sand in equal proportions; this mixture has the added advantage that it will be free from eelworms or other harmful pests, if subsequent contamination is prevented. Fumigation of such a mixture is unnecessary.

For all other soils, fumigation is recommended, not only because it kills eelworms, but also because it tends to eliminate other pests such as white grubs (Kehl and Piyasena, 1956). These may sometimes do as much harm to young plants as eelworms. *The use of eelworm-free soil is absolutely essential in order to prevent the spreading of eelworms from the nursery to the field.* Eelworm infestation of the young plants will adversely affect their establishment in the field as well as render useless any measures taken in the field to get rid of the infestation there.

Soil fumigation can be carried out with Nematox 100, or Shell D.D. or Nemagon at the recommended rates, applying one injection per square foot (Loos, 1953, 1954). The soil should be well watered and thatched after fumigation.

Although a period of 5–7 weeks after fumigation is ample for the disappearance of possible phytotoxic effects, it is advisable to allow at least 10–14 weeks to elapse before the soil is used for propagation or the filling of baskets. After leaving the soil *fallow* for such a period, it is unlikely that any healthy eelworms would remain, especially after a low initial eelworm population, for the few which survive fumigation would normally die from starvation.

An alternative method of getting rid of parasitic eelworms is to cultivate marigolds in the nursery beds (and paths) for 5–7 months. When sown between rows of Guatemala grass cuttings, a double purpose is achieved, namely, soil improvement and the suppression of parasitic eelworms.

Finally, it is recommended that the *entire* nursery, including paths, is fumigated or reconditioned to prevent contamination from the untreated portions. If that is not possible, the treated area should be separated from the untreated part by a deep drain. Similarly, deep trenches should be dug around the edges of the nursery, to reduce the chances of re-infestation by soil wash and by drain water from surrounding areas.

Eelworms and Replanting

Depending on the condition and yield of an eelworm-infested field, one can either decide to keep infestation within bounds by paying greater attention to agricultural practices, such as thatching, applying heavy dosages (10 to 20 tons/acre) of compost or manure, or one can have the tea uprooted and the area replanted.

If the infestation is moderate and has been discovered before too many casualties have been suffered, and the yield is still satisfactory, thatching and manuring may well be economical. Maintaining or promoting vigorous root growth under such circumstances is important. Re-supplying, if necessary, might be undertaken to increase the stand of the bushes but re-supplying is usually difficult even under normal conditions and can be successful only when carried out with eelworm-

tolerant (or eelworm-resistant) material. Only well-grown basket plants should be used for supplying. Fumigation of the vacancies, or at least of the plant holes, 4–6 weeks in advance and mixing in compost or stable manure at the time of planting will assist the establishment of the plants. If the vacancies are fairly large (to be preferred when re-supplying) reconditioning with marigolds (for 6–7 months), or with Guatemala grass (at least one year), may be feasible, though in the latter case the surrounding tea bushes may suffer from competition.

If the field is already in a bad state and its yield marginal, it is doubtful whether anything more could be achieved by improved bush and soil management than the masking of the detrimental effect of eelworm attack for some time. In such a case it would perhaps be better to replant. Since the Tea Replanting Scheme provides subsidies, it is likely that many estates would decide to take advantage of the scheme. It is compulsory to recondition the soil of such areas properly and advantage can be taken of this to reduce the population of parasitic eelworms, notably meadow-eelworms, to a minimum. If the compulsory reconditioning does not cope with eelworms, replanting is likely to be an economic failure.

An example given in the table below may illustrate this point; it presents the yield data from two fields on an estate in the Dimbula district, which were planted about twenty years ago (with seed) without rehabilitation, after the uneconomic old tea had been uprooted.

Average yield per acre/year	Lightly infested; planted in 1941. 25 acres	Heavily infested; planted in 1938. 43 acres
Since in bearing	687 lb.	487 lb.
Over 1951–1957	746 lb.	580 lb.

It appears that the yields of the two fields, particularly that of the older field, have been unsatisfactory throughout. It is doubtful if they could be improved sufficiently to cover the cost of improvement. Probably both the lack of soil reconditioning and the presence of parasitic eelworms have contributed to the comparatively poor results of replanting in this case.

Reconditioning

It is clear that no effort should be spared to reduce to a minimum the eelworm population of areas which are to be replanted; similarly the soil should be so improved that the young plant has a fair chance of establishing itself.

The method of reconditioning most widely recommended so far is the cultivation of Guatemala grass; this crop, besides being resistant to meadow-eelworm, provides a very considerable bulk of organic matter, both above and below the surface of the ground. For eelworm control, and for soil protection too, *combined cultivation of Guatemala grass and marigolds* is preferable. As Guatemala grass takes, at up-country elevations, at least 6–8 months to become established, planting of this grass alone means that the soil is left exposed for a considerable time.

In recent trials at two up-country estates, marigolds sown between the grass rows almost fully covered the soil within 2½ months after sowing. At that time the grass cuttings had shown little growth. If a vigorous variety is used, it is unlikely that the marigolds will degenerate before the Guatemala grass is fully established and growing vigorously. In the meanwhile they will have effectively suppressed

the parasitic eelworm population, prevented undue soil erosion, and provided additional organic material.

The grass cuttings should be planted at 2 × 2½ ft. and the marigolds sown in between in two or three rows, 9″–12″ apart, and in shallow ruts of 1″–2″ deep; loosening the soil will favour subsequent growth. It is estimated that at least 5 lb. of (pure) seed will be required per acre; mixing the seed with a bag of tea fluff or paddy chaff will facilitate sowing.

Marigolds respond markedly to manuring; it would therefore seem worthwhile to broadcast at the time of sowing, a dressing of *e.g.* 1 cwt. of a balanced animal meal per acre mixed with some bags of tea fluff. Thereafter, depending on growth, manuring may be repeated with the standard mixture recommended for Guatemala grass (Tolhurst and Portsmouth, 1956; Tolhurst, 1958).

The large varieties of marigold used in our trials were found to stand up well to lopping at about 2 ft., provided this was not done too early but before flowering. It is likely that with generous manuring they can be lopped several times before the grass is ready to be cut.

As imported seed is expensive and often less suitable than the semi-wild varieties growing locally, planters are advised to produce their own seed from these varieties. The large bushy type is preferable. There should be no difficulty in obtaining sufficient seed eventually, for marigolds are prolific seed-producers. The correct time for sowing would appear to be in the latter half of the wet season; seed must be collected during the dry season, or the viability of the seed tends to be poor.

Thus, in my opinion, soil reconditioning with Guatemala grass and marigolds together is well worth trying. One is likely to find that, on not too poor soils and with liberal manuring, soil reconditioning with both crops will be much more effective in suppressing eelworms and more efficient as regards soil protection, while requiring a shorter period, than with Guatemala grass alone.

Other cover crops may also be used *in combination with Guatemala grass.* It is possible that, at low- and mid-country elevations, other fast-growing plants may be applicable. None of these is known to be as valuable as marigolds in suppressing eelworms and, at least at up-country elevations, marigolds have been found to grow more quickly than alternative cover crops.

Summary

Eelworms are to be expected in any mono-crop. Mature tea suffers from meadow eelworm, which cannot be eradicated from the tea. The trouble is likely to increase steadily as the time under one species of crop increases. It is therefore vitally important to take advantage of replanting for clearing eelworms out of the replanted area. This can be done by normal reconditioning of the land with Guatemala grass; it can be helped and accelerated by interplanting the grass with marigolds.

Once mature tea is infested with meadow eelworm, the only thing to be done, apart from replanting, is to keep the bushes as vigorous as possible by cultural and manuring methods that ought to be used in any case.

Young plants are susceptible to attack by another species, root-knot eelworm. It is essential to ensure that nurseries, especially for tea and for *dadap* and *Albizzia sumatrana*, should be completely cleared of this species and kept clear. It is also important not to introduce meadow eelworm into the fields from the nurseries, either in tea or in shade, cover, and green manure plants. *Tephrosia vogelii* is susceptible to both kinds of eelworm and should not be used because it encourages their multiplication and spread.

For nurseries, a fresh mixture of peat, sub-soil and sand is good because it works well and is free from eelworms; all other soils should be fumigated, whether

known to contain eelworms or not; old tea soil should never be used. Fumigation should extend to the immediate surroundings of the nurseries (paths) and trenches should be dug around them to prevent eelworms migrating into the nurseries.

References

Kehl, F. H. & Piyasena, M. (1956). Report of the Plant Physiology Dept. for 1955. *Ann. Rep. Tea Res. Inst. Ceylon, Bull. no.* 37: 40–50.

Loos, C. A. (1953). The principles of pest control. IV. Eelworm. *Tea Quart.*, **24:** 34–38.

Loos, C. A. (1954). A note on soil fumigation. *Tea Quart.*, **25:** 41 (17).

Loos, C. A. (1956). Report of the Pathologist for 1955. *Ann. Rep. Tea Res. Inst. Ceylon, Bull. no.* 37: 51–52.

Tolhurst, J. A. H. & Portsmouth, G. B. (1956). Miscellaneous notes: manuring Guatemala grass. *Tea Quart.* **27:** 45.

Tolhurst, J. A. H. (1958). A summary of the Institute's recommendations on soil rehabilitation prior to replanting. *Tea Quart.* **29:** 251–252.

Visser, T. (1958). Report of the Physiologist for 1957. *Ann. Rep. Tea Res. Inst. Ceylon, Bull. no.* 39: 39–46.

Visser, T. (1959). Observations on the prevalence and control of parasitic eelworms in tea. *Tea Quart.* **30:** 98–109.

Visser, T. (1959*a*). Report of the Acting Nematologist for 1958. *Ann. Rep. Tea Res. Inst. Ceylon:* 67–73.

Visser, T., Kehl, F. H., & Tillekeratne, L. M. De Waas (1959). Propagation of tea cuttings. I. Soil and nutrient requirements. *Bull. Tea Res. Inst. Ceylon* N.S. no. 1: 1–15.

Visser, T., & Vythilingam, M. K. (1959). The effect of marigolds and some other crops on the *Pratylenchus* and *Meloidogyne* populations in tea soil. *Tea Quart.* **30:** 30–38.

*NOTES ON DRUM WITHERING

Angus F. Hutton

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Introduction

Conventional withers are carried out in elaborate multi-storey factories on banks of tats. Leaf is spread at about 1 lb. per 10 square feet and various fans and heaters and other methods of controlling air movement and temperature are employed with varied success; in other cases, nature is relied upon to do the work unaided by mechanical means. The former method is known as "artificial withering" and gives a great deal of control, especially when there are adverse ambient conditions. This method has reached its perfection in Ceylon and South India, while the natural method is the one commonly employed in N.E. India and much of Africa. Withering periods vary from 12 to 36 hours. Much labour is used to spread the leaf and recurring expenditure is involved on maintenance and replacement of tats.

The Sirocco withering drum gives a fully controlled wither more quickly, with very little labour, with a smaller outlay on building and equipment than any other means, with virtually no recurring expenditure on maintenance, and with a very low consumption of fuel.

Withering Drums

Attempts at withering leaf in drums, hot-air boxes, tunnels, etc. have been made many times during the past 60–70 years. Most have failed. The Sirocco withering drum, however, has achieved considerable success since its advent in 1952; many experiments have been done by the makers' overseas engineers; and experience has been gained on estates which have installed these drums—mainly in Africa, where over a hundred of them are now in use.

The Mark II withering drum is divided into two sections with four compartments in each and is designed to work at a speed of $1\frac{1}{2}$ R.P.M. Hot air is supplied from a Sirocco No. 8 air heater, which can provide enough for four drums. Temperatures are controlled by two potentiometers mounted on the control panel and actuating a control unit which opens and closes dampers on the hot-air and cold-air inlets, keeping the temperature within $2\frac{1}{2}$°F of whatever temperature it is set for. The original idea was to wither the leaf at an inlet temperature of 130°–140°F for $\frac{1}{2}$–1 hour (to dry off surface moisture), using the high range potentiometer, and then to switch to the low range instrument for a further 2–$2\frac{1}{2}$ hours at an inlet temperature of 100°–120°F. Provision was also made for running on cold air only. Air was provided by a fan adjacent to the mixing chamber and this escaped after passing through the leaf by means of the perforated sides and doors of the drum compartments. A charge of 1,600 lb. of leaf per drum or 200 lb. per compartment was aimed at, with a recommended wither equivalent to a 38% out-turn of made tea to withered leaf.

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* *The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.*

Early operating conditions, difficulties and modifications

An early difficulty was the odd leaf left over above a full drum charge. A simple solution was a butterfly valve fitted half way up the central trunnion and operated by a lever at the end of the drum. This shut off the end half of the drum to make it possible to use half charges. Another early difficulty was uneven withers, the leaf in the section nearest the fan withering more quickly than the end section. This was overcome by enclosing the sides of the drum, leaving only the perforated door for the air to escape through. The next difficulty was the question of whether or not to store leaf before "drumming." Experiments proved conclusively that leaf stored on racks or moveable trays for up to twelve hours before drumming was superior to leaf stored by other methods. A slight loss of moisture of 4 to 6% takes place on the racks.

The next difficulty was to match drums to drier capacity when the withering period had to be extended in wet weather. Running the drier empty for certain periods, or the addition of a drum, would have solved the problem, but some other more satisfactory means had to be evolved to close the gap. It was found that by increasing the fan speed and introducing a greater volume of air, withers could be speeded up, but this, in itself, was not enough and some other means had to be found without prolonged high temperatures.

Exhaust Control

Exhaust control was based on the finding that even at the high inlet temperature of 180°F in the early stages of withering, the air after passing through the leaf left the drum at a temperature of about 85°F. Therefore it was assumed that so long as the exhausted air was controlled to 85°F, the inlet temperatures would not matter, as they would automatically be reduced as withering progressed, till finally the inlet temperature would be only about 15° more than the exhaust temperature. The potentiometer element was therefore moved so that the exhaust air played on to it and the exhaust temperature was thus controlled to within ± 3° of 85°F. The results, as recorded on a thermograph, were surprising. As soon as the drum was charged and started up, the inlet temperature moved up to anything between 170°–220°F for a few minutes, according to the state of the leaf, then settled down to about 160°F and then, over a period of three hours, slowly dropped to 95°–105°F, when the leaf was discharged.

This method, known as "Exhaust Control," considerably improved the teas but made no appreciable difference to the withering times; but it was found that the high initial temperature had a detrimental effect on quality.

Lower exhaust temperatures of 80°F and less were tried, but they were not successful, for the instrument was working at the limit of its scale, where it was not sufficiently sensitive; moreover, since the daytime ambient conditions were often above 80°F, the control was influenced by atmospheric temperature and could be used only at night. At night, with an inlet maximum of only 140°–150° and with the same reduction of temperature over three hours, the quality of the tea was much improved.

Hot Air versus Cold Air

Experiments were carried out, when ambient conditions were favourable, on withering leaf in the drum with cold air only, at night, over a period of twelve hours. The results were most encouraging: It was most noticeable that quality, which had been lost with the heat in the controlled drum, was now present even with hard withers. The old bugbear of leaf blackening in the drums was still

present, though to a lesser degree. Dull teas were generally the order of the day during the rainy season and this was attributed to the longer period in the drum and the heat causing pre-fermentation.

Percentage Wither and Out-turns

It had meanwhile been established that an out-turn of 42–44% M.T./W.L. was far superior to the 38% figure quoted originally and that a much blacker well-twisted tea resulted.

Reduction of Leaf Movement

As previously mentioned, the blackening of the leaf, which had been thought to be due to heat, but which was present (though much less noticeably) even when only cold air was used, was still a matter of some concern, particularly with harder withers. It was realized that the blackening was caused by bruising, through the movement of the leaf in the drums. So it was supposed that if the drum were slowed up by half, bruising might be reduced by half as well, so long as only cold air was being used or very low temperatures; with higher temperatures, scorching could occur in certain places in the drum. It was then found that using cold air at night, the appearance of the leaf was much better and really hard withers could be obtained without loss of quality.

Pre-Withering in Drums and Doubling of Charges

It was found that after three hours of withering on cold air, when ambient conditions were favourable, a wither of 75–80% had already taken place, with a bulk reduction of 50%. It was therefore decided to try doubling up the drum charges with partly withered leaf in order to reduce leaf movement.

In the case of a factory with three drums, two were charged together and run for three hours on cold air. One drum was then discharged, door by door, and added to the first drum, so that the original two charges of 1,600 lb. each had been converted to a single charge of 2,400–2,500 lb. of partly withered leaf; this filled the drum compartments nicely, without packing down, and left much less room for movement. The wither was continued for a further nine hours. On discharge it was found that the leaf appearance was excellent, and the wither very even. One minor problem in the past had been to wither the stalks to the same extent as the leaf, but this was now solved.

The new programme, which matched the drier fairly well, is shown in the following table:—

New programme with three MK. II Drums Charge: 1,600 *lb. per drum initially*

Times:	*Drum No.* 1	*Drum No.* 2	*Drum No.* 3
6 p.m.	(A) IN	(B) IN	
9 p.m.		(B) OUT (to No. 1)	(C) IN
10 p.m.	DOUBLED UP (A+B) IN	RECHARGED (D) IN	
12 p.m.		(D) OUT (to No. 3)	
1 a.m.		RECHARGED (E) IN	DOUBLED UP (C+D) IN
7 a.m.	(A) OUT		
8 a.m.	(B) OUT		
9 a.m.			(C) OUT
10 a.m.			(D) OUT
11 a.m.		(E) OUT	

With three drums, up to five charges, or 8,000 lb. of leaf, can be dealt with in this way and with four drums, up to 11,200 lb. of green leaf can be dealt with similarly, and so on, discharging every hour.

This worked well in dry weather when ambient conditions were right, but, when the rains came, some alteration was necessary. As it was known that high temperatures caused loss of quality, it was decided to try a low inlet-temperature, with the idea of just drying the air. For convenience, 85°F inlet was tried—it being a simple matter to remove the potentiometer element from the exhaust control position to the original inlet control position and *vice versa*. This system has worked very well under the worst possible climatic conditions and also applied itself very well to the new programme of "Double Drumming," with the added advantage that the initial pre-wither can be done in 2–3 hours and the remaining period in about 10 hours on cold air or about seven hours on hot air at 85°F.

Conclusions

Samples of all these experimental wither teas have been favourably reported on by London brokers, stage by stage, and it now appears that the ideal way to use drums is:—

(1) 1,600 lb. initial charges for drums;

(2) pre-wither at 85°F inlet temp. or cold air for 2–3 hours;

(3) double-up drums after pre-wither to reduce leaf movement;

(4) run drums at speed of $\frac{3}{4}$ R.P.M. (or less);

(5) when ambient conditions are favourable, use cold air (after pre-wither) for remaining period in drums (7–10 hours);

(6) when ambient conditions are not favourable, continue to use hot air at 85° inlet for remaining period of 6–9 hours;

(7) an out-turn of 44–46% M.T./W.L.=about 55% withers in the dry months is aimed for;

(8) an out-turn of 40–42% M.T./W.L.=about 50% withers in the wet months is aimed for.

There is a considerable saving in firewood by using low temperatures; $\frac{1}{2}$–1 cu. yd. per 4,800 8,000 lb. of green leaf is sufficient and of course the capacity of the drums is doubled but the power used remains unaltered.

It is estimated that six drums worked off one suitable air heater at 85° inlet temperatures, with two 6′ driers and nine rollers, would deal with about 17,600 lb. of green leaf per day.

Many of the modifications mentioned have now been incorporated into the design of the latest drums, which are believed to be greatly improved; but the writer believes that the withering drum, though here to stay, still offers a great challenge for continued improvement not only to withering, but to the whole process of tea manufacture and factory design. It is worth mentioning that many of the top-priced African teas today are made using withering drums.

Acknowledgments

The writer would like to express his appreciation to his employers and to the management of the estate for their assistance and the co-operation which have

enabled many experiments to be carried out both individually and collectively and with the advice and co-operation of Messrs Davidsons representatives in East Africa. To the Company's Tea Brokers, both in Nairobi and in London, a special word of thanks is due for their unstinted advice and reports on samples submitted, which have been most useful.

COMMENTS ON MR HUTTON'S NOTES ON DRUM WITHERING

E. L. Keegel

The foregoing notes were received from Mr G. K. Newton, now with the Uganda Development Corporation Ltd., to whom we are grateful for sending us the latest information on a subject which is of considerable interest to the tea industry in Ceylon.

The withering drum has for a long time been considered as a possible substitute for or supplement to the traditional withering lofts. In the past it has not been recommended by the Institute. It now appears from the results of the experiments carried out in East Africa that the manufacturers of the drum and its users have at last realized that it does not pay to wither leaf for short periods at very high temperatures. There was conclusive evidence at the T.R.I. that such high temperatures are harmful to quality and for this reason the Institute was always firm in stating that the withering drum, under the conditions of operation then recommended by the suppliers, was not suitable for Ceylon.

Judging from the claims now made for the withering drum, the technique appears to be giving much more satisfactory results. The fact that some of the best African teas today are made using the drum does not, however, prove that the drum-withering method is preferable to the tat-withering system. It may be that the latter has not yet reached the same degree of perfection as in Ceylon. It is also possible that the type of rolling adopted in East Africa is perhaps fundamentally different from that in Ceylon. On the other hand the leaf itself may be more suited for drum withering.

When comparing two processes one may draw the wrong conclusions even though there is only one variable factor. In this particular case, for instance, a harder wither for tat withering and possibly harder rolling might give a tea superior to that now obtained. The standard for comparison with drum withering could very well then have not been high enough. One must therefore be rather cautious in accepting the results of any particular treatment until we know all the circumstances. A statement which may be perfectly true for Africa may be inapplicable to Ceylon. Be that as it may, the tea industry in Ceylon will have to examine the possibilities of withering drums for the increasing crops. Extension of withering lofts in some factories appears to have reached the limit, and increasing withering accommodation in others has brought other problems in its train. If the Sirocco drum fulfils the necessary requirements it would certainly meet an important need.

It will be noted from the article that three very important changes have been introduced in the drum-withering system. They are:—

1. considerably reduced speed;
2. extension of withering period by the employment of temperatures more in keeping with what has been found suitable for Ceylon conditions;
3. harder and more conventional withers.

Examination of the table in the article reveals that the withering periods are as follows:—

A	(1st batch)	—	13 hours
B	(2nd „)	—	14 „
C	(3rd „)	—	12 „
D	(4th „)	—	12 „
E	(5th „)	—	10 „

These periods do not even include the period the leaf is stored in the interval between arrival at the factory and charging into drums. Thus it will be seen that whereas in the past the withering period was as short as four hours or even shorter, it is now prolonged to such an extent that it is not much different from that which has given very satisfactory results in some factories in Ceylon today. The complications in factory organization involved by the adoption of very short periods hitherto have also been partly eliminated, as seen in the programme given in the table.

One of the advantages claimed for withering drums and similar mechanical devices is that the withering period is considerably shortened. It has never been apparent to us how shortening unduly the period of wither helps in any way, and far from being advantageous, periods of the order of 3–4 hours seriously interfere with normal factory routine and necessitate abnormal hours of work. It is pleasing therefore to note from Mr Hutton's article that the idea of accelerating the wither has been abandoned. Coupled with the incorporation of lower temperatures and less damage to the leaf (by the extremely slow speed of the drum and less leaf movement), the present system of drum withering as described by Mr Hutton might well prove successful in Ceylon too. Its possibilities therefore as a contribution to the solving of the problem of inadequate withering accommodation may now be worth examining.

The reader's attention is invited to the Technologist's reports in the T.R.I. Annual Reports for 1952, 1953 and 1955, which refer to a system of mechanical withering which was much like the present drum withering system, except that the leaf was turned over at regular intervals instead of being moved continuously.

DEFICIENCY DISEASES AND THE SYMPTOMS OF MAGNESIUM DEFICIENCY

D. Mulder and R. L. de Silva

Introduction

The recognition of mineral deficiency and toxicity symptoms in the field is of the utmost importance in crop-culture. A deficiency symptom does not normally develop until the supply of the essential element is well below the amount required for good health. This means that, if the planter sees a deficiency symptom, the needs of the crop have not been met for some years. A deficiency symptom should therefore act as a red light, an emergency signal from the plant, and the grower should react.

Types of Deficiency Symptoms

Deficiencies of some elements affect the whole appearance of the plant. This is well known for nitrogen, phosphorus and sulphur. Other deficiencies affect only a particular part of the plant and the symptoms and their location presumably depend on the physiological function of the deficient element. This kind of localised reaction occurs with potash, calcium and magnesium.

Trace-element deficiencies cause rather localized symptoms as a rule but, when their function is connected with growth, as with zinc and boron, they can also have an over-all effect.

In its severest form any deficiency can suppress growth, though the initial effects may be rather localized.

Some elements are fixed and accumulated in the older leaves, with no possibility of transport to younger parts. A deficiency of such an element tends to cause symptoms in the growing parts. This is the situation, for instance with calcium, iron, and boron. Other elements, such as potassium and magnesium, are readily transported from older parts to new parts of the plant; the result is that the deficiency shows up first in the older parts, which are depleted of the element to supply younger growing parts.

The different functions of the mineral elements result in very varied deficiency symptoms but some classification is possible.

(1) *Chlorosis* of the leaves is a yellowing due to lack of chlorophyl; it always indicates the deficiency of an element which functions in the building or the maintenance of the chlorophyl, namely nitrogen, sulphur, iron, manganese and zinc, which are related to the formation of chlorophyl; their deficiencies show up in the younger leaves. Magnesium is actually a part of the chlorophyl molecule; if it is deficient, chlorophyl is broken down in the older leaves, making them chlorotic, and the magnesium is removed to the actively growing leaves.

(2) *Necrosis* of leaf or stem tissue consists of the death of certain tissues; it can be due to various causes and connected with many functions of elements. Marginal or inter-venal necrosis of leaf tissues is linked with potassium and magnesium deficiencies. Potassium deficiency almost always results in marginal leaf necrosis;

magnesium deficiency results in marginal or inter-venal necrosis only if there is an abundant nitrogen supply. Necrosis of young leaves is characteristic of calcium deficiency; this symptom is probably linked with the function of calcium as a part of calcium pectate in the cell walls.

Vegetation points and bark tissue (phloem) are specially liable to necrosis due to boron deficiency. Boron has an especially important role in growth processes. The same is true for zinc and copper, the deficiencies of which also can cause a serious general collapse of vital growth processes. A fourth deficiency causing necrosis in growing tissues is that of molybdenum.

(3) *Stunting* of plants is just a milder symptom of the above-mentioned deficiencies and is especially seen when there is a deficiency of zinc or boron and less commonly of molybdenum or copper.

Influence of Weather Conditions on Symptom Development

Both sunshine and rainfall have an effect on the development of symptoms (Wallace, 1951).

Nitrogen-deficiency symptoms develop more clearly under conditions of high intensity of light. Some tea clones (*e.g.* the fast-growing TRI 2024) show this clearly.

Symptoms of potash deficiency are more severe under dry-weather conditions.

Deficiency symptoms of magnesium can be pronounced during a wet season, because this element leaches out of the soil; but a high light-intensity has also the effect of increasing magnesium-deficiency symptoms by direct physiological action.

Regarding trace elements, iron and zinc deficiencies are more severe under conditions of high light-intensity. Zinc has a function in the production of growth hormones; if there is a shortage of zinc there is also a shortage of growth hormone; light has the effect of decomposing growth hormones and thereby diminishing the growth. If there is already a shortage of growth hormone due to zinc deficiency, the decomposition of the hormone by sunshine leads to a more severe shortage of hormone and consequently to a stunting of the plant.

Symptoms of boron deficiency are much more pronounced during a dry period due to lower availability of boron in the soil.

Review of Literature on Magnesium Deficiency in Tea

The symptoms of magnesium deficiency in tea were first obtained artificially in sand culture (De Haan, 1941) as follows:—

"In the case of magnesium deficiency, the old mature leaves go a light yellow colour, with the exception of the parts situated immediately along the veins. Sometimes the whole outer half of the leaf has a light yellow to white discolouration. The young leaf is at first normal in colour and development is normal. The old leaf is sometimes slightly folded convexly. Along the margin of the leaf, between the ends of the veins, there occur now and then brown dead patches, but this is not very characteristic" (translated from the Dutch).

In 1954 Tolhurst gave the following description of magnesium deficiency symptoms as found in the field:—

"Apart from poor growth the main points of note were the dullness and brittleness of the old leaves with, in some bushes, a pronounced folding upwards along the midrib. The leaves were not much reduced in size. The colour was pale and without the dark bluish green seen in a healthy leaf. The most characteristic symptom however, was a diffuse yellowish brown to coffee coloured mottling which

appeared as a vague mosaic between the main veins and towards the centre of the leaf. Individual bushes vary in details, but the general similarity of the symptom is apparent. The brown areas have never been seen to reach either the midrib or the leaf edge, or to cross one of the main veins."

From these two descriptions, it can be seen that the symptoms may vary widely according to the type of tea, the severity of the deficiency, and the type of leaf observed. The observations by De Haan referred to the lower leaves on plants growing up freely and he emphasized the yellow colour; Tolhurst was concerned mainly with the older leaves in the plucking table and he emphasized the brown areas between the veins.

Chenery (1959) has just described magnesium deficiency in tea in East Africa. He puts special emphasis on the appearance of a "well-defined inverted green V at the base of the chlorotic leaves" and in other cases a "herring bone pattern of main veins on a yellowish-green to brown or yellow background." Both descriptions apply to Ceylon tea. We agree with Chenery that folded leaves are not characteristic.

Since the description given by Tolhurst, the frequency of symptoms of magnesium deficiency has probably increased in tea in Ceylon; in 1958, a vivid yellow discolouration of the lower leaves was the most apparent symptom. At higher elevations a brown discolouration does occur on plucking-table leaves that have shown the chlorosis for a long time.

The Place of Magnesium Deficiency Symptoms on the Tea Bush

The two main factors influencing the occurrence and increasing the severity of magnesium-deficiency symptoms are high intensity of light and high rainfall. Since the leaves of a bush are not all equally illuminated, we may expect the symptoms to occur in their severest form on those leaves that receive the largest amount of light. If all leaves received the same light intensity, then the oldest leaves should show the most severe symptoms, because it is well known that the older leaves are gradually depleted of magnesium for the benefit of deficient growing leaves.

An approximately uniform distribution of symptoms over all the older leaves occurs only on young plants that grow up freely without being pruned and that stand far enough apart not to shade each other. This pattern has been seen on a few plants that grew up freely to a height of about ten feet near an experimental plot at St. Coombs.

Clear symptoms on the lowest leaves can also be expected on clonal plants before they are pruned for the first time, because plenty of light can penetrate to the inner region of the bush. As soon as the bushes start covering the soil, however, and a plucking table has been developed, then the situation changes completely because very little light penetrates below the plucking table. This leads to a peculiar distribution of the symptoms in bushes some years after the first pruning. Depending on the density of the foliage, one finds the symptoms at the level of the plucking table in the first mature leaves and from there downwards in rather rapidly decreasing numbers in older leaves. In this case we do not find any symptoms on the lowest leaves in the bush but we find a severe chlorosis immediately below the growing shoots. On exposed sides of the field along roads we find the same symptoms on lower leaves as well.

Because of the practice of plucking, the distance between chlorotic leaves and young growing healthy leaves is very much reduced, as compared with the situation in freely-growing crops. As a rule one finds on woody shoots, between the chlorotic, magnesium-deficient, leaves and the growing tip, some mature leaves that are not yet affected by the chlorosis. Because we compel the bush repeatedly to produce

new shoots from old dormant buds near old leaves, these old leaves become more and more depleted of magnesium and exhibit the chlorosis.

With a less dense plucking table, the chlorosis may develop mainly on leaves lower down in the bush and may easily be overlooked.

The Range of Symptoms

Chlorosis is the most characteristic symptom and direct effect of magnesium deficiency. After the development of chlorosis, a further process of deterioration may take place in the form of browning of the leaf surface due to necrosis of the cells. Acute sun-scorch may also develop in the chlorotic area. Finally, marginal or inter-venal necrosis may occur, but this stage has only rarely been observed in Ceylon*. The chlorosis may develop in many different patterns. On leaves of low-jat clones the chlorosis is, as a rule, more evenly spread over the leaf, with only some green tissue left along the midrib. In the last stages, low-jat leaves are almost completely yellow.

High-jat tea reacts in a different way; the chlorosis starts as patches of inter-venal and marginal yellowing which can resemble manganese deficiency. Later, this yellowing increases and develops into a clear marginal and inter-venal chlorosis, leaving only a narrow strip of green along the midrib.

A common symptom of magnesium deficiency in woody plants is the shedding of the chlorotic and necrotic leaves. This has not been observed on tea. It is quite possible, however, that in magnesium deficiency the life of the maintenance foliage is shorter and the total number of leaves remaining on a bush therefore smaller.

Sensitivity of Plants grown from Seed and Clonal Material

In tea bushes grown from seed, the sensitivity to magnesium deficiency must vary from bush to bush; in clonal material, on the other hand, all the bushes in one clone must have the same inherent sensitivity. Deficiency symptoms are therefore likely to show up more dramatically in some clonal plantings than in old mixed tea; there is, however, no reason to suppose that the clones in use are *on the average* more sensitive than material from seed. There may, however, be an effect: because clones are selected for vigorous growth, they may show deficiency symptoms earlier and more clearly.

There is no doubt that several clones, both high jat and low jat, are very good indicators for magnesium deficiency. Of the high-jat clones, TRI 2024 and TRI 2023 are good examples. TRI 2025 seems to be more resistant. The low-jat Court Lodge clone CL 72 is outstanding in sensitivity to magnesium deficiency, as are also Court Lodge CL 26 and Moray 23. The fact that these clones develop the symptoms so clearly does not automatically mean that they also suffer more from this deficiency. Other plants that do not show symptoms so easily might suffer in some other way not visible to us and their growth might be retarded to the same extent. We should therefore be grateful to the clones that do show symptoms, because they indicate the needs of the soil so clearly in this respect.

Coloured Pictures of Deficiency Diseases

A series of coloured plates has been published by De Haan (1941), showing the deficiency symptoms of calcium, magnesium, phosphorus, nitrogen, and sulphur.

* It is a well-known fact that necrosis develops severely only at high nitrogen level. Perhaps we have not reached such a high nitrogen nutrition in Ceylon or perhaps high rainfall prevents the development of such a high nitrogen level.

Marginal and intervenal chlorosis on mature leaves of tea clone T.R.I. 2024 due to magnesium deficiency

Potash-deficiency symptoms were illustrated in colour in the *Tea Quarterly* in 1953 by Portsmouth. Since then, no pictures of this kind have been published and nothing is available for the Ceylon planter. Tolhurst mentioned the need for such plates in 1954 in connection with magnesium-deficiency symptoms. It is hoped that the coloured plate presented here will be the first of a series of pictures of deficiency symptoms and other signs of diseased conditions of the tea bush.

The picture illustrates only a few variants of the symptoms of magnesium deficiency and the planter needs to study his own bushes and find the resemblances between his trouble and the present illustration. We do not claim to cover the full range of symptoms that might be associated with magnesium deficiency.

Separate reprints of this plate are available from the Institute at cost price. The idea is to have a series of plates assembled in a special cover into which the plates can be put one by one as they become available.

Leaf and Stem-Injection Experiments for the Diagnosis of Lower-Leaf Chlorosis

The methods of Roach and Roberts (1945) for identification of mineral deficiencies have been applied to lower-leaf chlorosis of tea but so far without useful result. It is possible that the leaves and stems used were too old for the purpose and could no longer react by producing new chlorophyl. It is planned to repeat these experiments with younger clonal material.

Field trials on magnesium deficiency in tea.—A summary of the two field trials carried out for the diagnosis of the symptoms of lower-leaf chlorosis, suspected of being due to magnesium deficiency, is given below. The symptoms, inter-venal yellowing on the lower leaves, were similar on the material used in both trials.

Method of assessment of the degree of chlorosis.—In the two field trials, the degree of chlorosis was measured by plucking about 25 leaves at random from the lower part of each bush, which is the region where the symptoms of chlorosis are most pronounced. The healthy leaves of the entire lot were separated from those showing symptoms of the typical inter-venal chlorosis, and the percentages of the chlorotic leaves were calculated (Table 1).

Trial No. 1

Location:—clonal area, No. 10 Field, St. Coombs Estate.

Material:—each treatment was applied to seven-year-old plants of Moray Clone No. 23 and was replicated twice.

Number of plants in each treatment=12.

Treatments

(1) Half a gallon of a *2% solution of magnesium sulphate (Epsom salts) was sprayed weekly on 12 plants for 33 weeks (*i.e.* 6–7 fluid ounces per plant per week).

(2) Half a gallon of a 2% solution of magnesium sulphate, into which a sticker had been incorporated, was sprayed weekly on 12 plants for 33 weeks.

(3) One gallon of a 2% solution of magnesium sulphate was injected weekly for 33 weeks into the soil around 12 plants, the points of injection being 9–12 inches away from the collar of each bush.

(4) Twelve plants were kept for 33 weeks as untreated controls.

(5) Half a gallon of a 10% solution of magnesium sulphate was sprayed weekly on 12 plants for 8 weeks.

(6) Half a gallon of a 5% solution of magnesium sulphate was sprayed weekly on 12 plants for 8 weeks.

* That is, 2% $MgSO_4$, 7 H_2O; this is about 1% $MgSO_4$.

(7) One gallon of a 5% solution of magnesium sulphate was injected weekly for 8 weeks into the soil around 12 plants, the points of injection being 9–12 inches away from the collar of each bush.

(8) Twelve plants were kept for 8 weeks as untreated controls.

TABLE 1.—*The effect of spraying or injecting magnesium-sulphate solutions on the occurrence of lower-leaf chlorosis*

Treatments	Duration of treatment	No. of applications	% chlorotic leaves
1. 2% $MgSO_4$ spray	19-9-58 to 23-5-58	33	6.1
2. 2% $MgSO_4$ spray with sticker	do.	33	6.7
3. 2% $MgSO_4$ injected into the soil	do.	33	42.8
4. Untreated control	do.	0	68.7
5. 10% $MgSO_4$ spray	29-5-58 to 31-7-58	8	nil
6. 5% $MgSO_4$ spray	do.	8	7.1
7. 5% $MgSO_4$ injected into the soil	do.	8	10.5
8. Untreated control	do.	0	53.8

TRIAL No. 2

Location:—clonal area, No. 4 Field, Court Lodge Estate, Kandapola.

Material:—each treatment was applied to seven-year-old plants of Court Lodge clone CL 72 (= PW 72), and was replicated four times.

Number of plants in each treatment=10.

TREATMENTS

(1) Half a gallon of a 2% solution of magnesium sulphate was sprayed weekly for 23 weeks on 10 plants.

(2) Ten plants were kept as untreated controls.

Table 2 shows the results obtained in Trial II.

TABLE 2.—*The effect of spraying magnesium-sulphate solution on tea plants showing lower-leaf chlorosis from* 11-3-59 *to* 12-8-59

Treatments		No. of applications	% chlorotic leaves
1. 2% $MgSO_4$ spray	Block 1	23	39.6
2. do.	Block 2	23	14.6
3. do.	Block 3	23	25.5
4. do.	Block 4	23	19.6
5. Untreated controls	Block 1	—	77.3
6. do.	Block 2	—	82.4
7. do.	Block 3	—	81.3
8. do.	Block 4	—	81.0

Discussion

From Table 1 it is evident that spraying of magnesium sulphate has been effective in diminishing the degree of lower-leaf chlorosis considerably. A 10% solution after 8 weekly applications caused the chlorosis to disappear almost completely. Sprayings with 5% and 2% solutions of magnesium sulphate were also effective, though to slightly lesser degrees. Soil injection with 2% magnesium-sulphate solution had no worth-while effect on the chlorosis, but soil injection with a 5% solution appeared to be more effective.

From Table 2 it is clear that spraying with 2% magnesium-sulphate has reduced lower-leaf chlorosis. There is a significant difference between the percentages of chlorotic leaves in treated and control plots.

Pot experiment on the influence of eelworm attack on magnesium deficiency in tea.— A preliminary pot experiment was devised to investigate the effect of foliar spraying and soil injection of magnesium-sulphate solution on plants growing in soil infested with meadow eelworm (*Pratylenchus coffeae* Sher & Allen, 1953).

Material.— 6-8 plants showing severe symptoms of lower-leaf chlorosis of each of the following six clones were used:—

(1) TRI 2024	(4) Drayton 95
(2) TRI 2025	(5) Delmar 10/2
(3) TRI 2135	(6) Diyanilakele 13

The plants were about five years old. The date of inoculation of the pots with meadow eelworms was 24th March, 1959.

The volume of soil in each pot was about 18 litres (two-thirds of a cubic foot).

The method of assessment of lower-leaf chlorosis was similar to that given above for the two field trials.

The following treatments were applied:—

(1) foliar spraying of 2% magnesium-sulphate solution, on plants growing in meadow eelworm-infested soils, at the rate of 1 gallon of solution per 25 plants weekly.

(2) foliar spraying of 2% magnesium-sulphate solution, on plants growing in soils free from meadow eelworm, at the rate of 1 gallon of solution per 25 plants weekly.

(3) 2% magnesium-sulphate solution was poured into the pots containing soils infested with meadow eelworm at the rate of 175 ml. per pot weekly. The total quantity thus applied was 87.5 grams $MgSO_4$ per pot for the 25 treatments.

(4) 2% magnesium-sulphate solution was poured into the pots containing soils free from meadow eelworm at the rate of 175 ml. per pot weekly.

(5) untreated controls in soils infested with meadow eelworm.

(6) untreated controls in soils free from eelworm.

Table 3 shows the effects of the sprays and of the soil injections on the degree of lower-leaf chlorosis in soils infested with meadow eelworm and in fumigated soils free from meadow eelworm.

TABLE 3.—*The effect of 2% magnesium-sulphate spray and soil injection, on the diminution of lower-leaf chlorosis on meadow-eelworm infested soils and on fumigated soils free from meadow eelworm (treatment from 23-2-59 to 12-8-59)*

Treatments	Eelworm present + absent —	No. of applications	% chlorotic leaves
1. Foliar spray ...	+	25	8.9
2. Foliar spray ...	—	25	3.8
3. Soil injection ...	+	25	5.9
4. Soil injection ...	—	25	6.4
5. Untreated control ...	+	0	66.9
6. Untreated control ...	—	0	63.8

Discussion

From Table 3 the following conclusions can be drawn:—

(1) The results obtained in the field trials are confirmed in the pot experiment, where the foliar spraying and soil injection of magnesium-sulphate solution considerably diminished the degree of lower-leaf chlorosis.

(2) The effectiveness of foliar spraying and soil injection of magnesium-sulphate solution in diminishing lower-leaf chlorosis is not much influenced by the presence of a heavy infestation of meadow eelworm in the soil; there is a very significant difference in the percentage of chlorotic leaves in the treated and control plants, irrespective of the meadow-eelworm infestation.

Summary

1. A general account is given of types of deficiency symptoms and of the influence of weather conditions on the appearance of these symptoms.

2. The literature on magnesium deficiency in tea is reviewed, in the light of symptoms of magnesium deficiency as now commonly found in Ceylon. Emphasis is laid on the occurrence of marginal and inter-venal chlorosis in mature leaves in the plucking table and in older mature leaves as far as they are exposed to full daylight, as the main characteristic symptoms of magnesium deficiency.

3. The effect of light on the development of magnesium-deficiency symptoms in connection with their occurrence on the tea bush is discussed.

4. A list of sensitive and more resistant clones is given.

5. The value of coloured pictures of deficiency diseases is discussed in connection with the addition of a colour plate of magnesium deficiency to this article.

6. Results are given of spraying on to the leaves of the plant and injection into the soil of magnesium-sulphate solutions of different strengths for diagnostic purposes.

Acknowledgments

The help is gratefully acknowledged of the field assistants, Messrs S. Murugiah and J. B. Dissanayake, in the work of spraying.

References

Chenery, E. M. & Schoenmaekers, J. (1959). Magnesium deficiency in East African tea. *E. Afr. agric. J.* **25:** 25–27.

De Haan, T. (1941). Deficiency symptoms on tea, caused by an insufficient supply with the most important nutrient elements except potassium. *Arch. Theecult. Ned.-Ind.* **15:** no. 1, 1–32.

Portsmouth, G. B. (1953). Potash deficiency in tea. *Tea Quart.* **24:** 79–81.

Roach, W. A. & Roberts, W. O. (1945). Further work on plant injection for diagnostic and curative purposes. *Tech. Commun. Bur. Hort.* E. Malling, no. 16: 12 pp.

Roe, D. (1958). Some observations on the use of magnesium sulphate for a chlorosis of tea. *Tea Quart.* **29:** 132.

Tolhurst, J. A. H. (1954). Magnesium and manganese deficiencies in the nutrition of the tea bush. *Tea Quart.* **25:** 84–86.

Wallace, T. (1951). The diagnosis of mineral deficiencies in plants by visual symptoms. (*London, H.M. Stationery Office.* 107 pp. + 312 col. plates.)

SUMMARY MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD IN THE GENERAL COMMITTEE ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, 73/1, KOLLUPITIYA ROAD, COLOMBO, AT 9 A.M., ON FRIDAY, 4TH SEPTEMBER, 1959.

Present.—Messrs F. Amarasuriya (Chairman), C. D. Green (Chairman, Agency Section, Planters' Association of Ceylon), H. Creighton (Chairman, Planters' Association of Ceylon), Dr M. F. Chandraratna, M.B.E. (Director of Agriculture), B. Mahadeva, C.C.S. (Tea Controller), R. M. Macintyre, A. D. McLeod, W. H. W. Coultas, N. M. Sanders, J. L. D. Peiris, E. Jayawickreme, D. E. Hettiarachchi, Reginald Perera, S. Jinadasa, M.P., Dr A. W. R. Joachim, O.B.E. (Director, T.R.I.), G. A. D. Kehl (Administrative Secretary, T.R.I.) and H. J. Balmond (Secretary, Board of Control).

Messrs H. E. Peries, O.B.E. (Deputy Secretary to the Treasury) and R. C. P. Adams intimated their inability to be present.

1. The notice convening the meeting was read.

2. **Minutes of the Meeting of the Board held on 5th June, 1959**

The minutes of the meeting of the Board held on 5th June, 1959, were confirmed.

3. **Matters Arising out of the Minutes**

(1) **Page 1—Item 3 (1) (a)—Acquisition of Mutwagalla Estate**

The Director said that it had been agreed to take over Mutwagalla Estate from 1st October, 1959, but there were legal delays. It was agreed that the Low-Country Sub-Station Committee interview the Vendor Company with a view to reaching a mutually satisfactory agreement between the Company and the Institute.

(2) **Page 2—Item 3 (ii)—Dr D. L. Gunn**

Reported that Dr Gunn would be arriving on 1st October, 1959. The report was received.

(3) **Page 3—Item 5 (i) (c)—Water Supply—Stage II**

Reported that the contract was offered to Messrs Brown & Company. This Company had agreed to undertake the work and had stated that their quoted figures remained firm notwithstanding the time elapsed between the date of tender and date of acceptance. The report was received.

(4) **Page 3—Item 5 (ii) (a) Visiting Agent**

Reported that Mr A. Mackie had accepted the appointment of Visiting Agent and would take up duties on his return from leave on 10th October, 1959. The report was received.

(5) **Page 3—Item 5 (ii) (d)—Provident Fund**

Reported that the Administrative Committee had considered in detail the proposal to pay enhanced Provident Fund benefits to Old Entrant Staff, and its recommendations were reported in the minutes of the Administrative Committee meeting held on 31st July, 1959. The Board approved the recommendations.

(6) **Page 3—Item 5 (ii) (e)—Scientific Advisory Committee in the U.K.**

Dr Tubbs's letter of 23rd June, 1959, addressed to the Chairman, was read, expressing his appreciation of the Board's resolution. The Director reported that the proposals for the formation of a Scientific Advisory Committee in the U.K. had been referred to Dr Gunn for his comments.

(7) **Page 4—Item 5 (ii) (f)—Dr S. C. Pearce**

The Director reported that Dr Pearce's report had been received and would be circulated to the Board and Experimental and Estate Committee for consideration. Dr Pearce had also written a popular article on his investigations which would be published in the next number of the *Tea Quarterly*. The report was received.

(8) **Page 4—Item 5 (ii) (g)—Overseas-recruited Scientific Staff salaries**

The recommendations of the Administrative Committee as reported in the minutes of the meeting of the Administrative Committee of August 15th, 1959, page 8—Item 6, were approved.

(9) **Page 4—Item 6 (ii)—Plant Breeder**

Reported that reciprocal arrangements had been made with the University regarding applications for posts from staff of the other institution. It was also reported that, as directed by the Appointments Committee, an application had been made to the United States Operations Mission to Ceylon for the services of a Plant Breeder of the status required. The position was, however, still fluid. The reports were received.

(10) **Page 5—Item 9—Staff:** Reported that—

(i) Mr J. A. H. Tolhurst, Agricultural Chemist

Mr Tolhurst resumed duties from medical leave on 24th June.

(ii) Mr G. D. Austin, Entomologist

Mr Austin had written expressing his thanks and appreciation to the Board for the leave granted to him.

(iii) Mr H. J. Balmond, Chief Administrative Officer

Mr Balmond assumed duties on 1st July.

The reports were received.

(11) **Page 6—Item 10 (ii)—Research Institutes**

Reported that the Directors and Chairmen of the three Research Institutes had met on 11th July, 1959, and the proceedings of this meeting had been considered by the Administrative Committee at its meeting held on 31st July, 1959. The recommendations of the Committee are reported in the minutes of the meeting of 31st July, 1959. The recommendations were approved.

4. Membership of the Board and Committees

The following changes were reported:—

(i) The Board

Ex-Officio

Mr C. D. Green, upon election as Chairman of the Agency Section of the Planters' Association of Ceylon, became an *ex-officio* member of the Board as from 23rd July, 1959. He takes the place of Mr G. I. de Glanville.

Mr H. E. Peries, C.C.S., resumed his seat on his return from leave relieving Mr D. G. L. Misso, C.C.S., as from 22nd June, 1959.

Representing the Planters' Association of Ceylon

Mr N. M. Sanders resumed his seat on his return from leave relieving Mr J. N. Atkinson as from 2nd July, 1959.

Representing the Agency Section, Planters' Association of Ceylon

Mr A. D. McLeod had been appointed to act for Mr R. J. Gilmour during the latter's absence on leave as from 25th June, 1959.

Mr R. M. Macintyre had been nominated to fill the vacancy created by Mr G. K. Newton's resignation with effect from 31st July, 1959.

(ii) Members of the Committees

(1) Administrative Committee

Mr A. D. McLeod was nominated to act for Mr R. J. Gilmour.

(2) Low-Country Sub-Station Committee

Mr Errol Jayawickreme was nominated to fill the vacancy caused by Mr G. K. Newton's resignation.

(3) Experimental & Estate Committee

Mr W. H. W. Coultas was nominated as representative of the Administrative Committee.

(4) Appointments Committee

Mr C. D. Green was nominated to fill the vacancy caused by Mr G. K. Newton's resignation.

5. Finance

(a) Institute's Accounts as at 31st July, 1959

The following were tabled:—

Balance Sheet of the Institute as at 31st July, 1959.
Asset Account of the Institute as at 31st July, 1959.
Statement of Research Revenue Expenditure and Research Capital Expenditure for July, 1959.
Estate Working Account as at 31st July, 1959.
Estate Revenue Expenditure for period ending 31st July, 1959.

The Chairman in moving the adoption of the Institute's accounts, including the estate accounts as at 31st July, 1959, stated that the profit on the estate was Rs. 163,906.43 to date.

The following points were raised during the discussion:—

(1) Estate Working Account at 31-7-59

Reported that the amount shown against Brokerage and Handling Charges to end July, 1959, includes the sum of Rs. 19,244.27 paid on the *ad valorem* tax on teas sold from June, 1959.

(2) Balance Sheet as at 31-7-59

Reported as follows:—

Current Assets

(*a*) *Recovery Account Rs.* 56,044.85 comprises all recoveries outstanding at the above date from the staff of the Institute. This includes vehicle and housing loan balances as well.

(*b*) *Debt Settlement Account Rs.* 16,892.88 is made up of recoveries outstanding on vehicle loans from St. Coombs Estate Staff (Rs. 6,500/-) and Small Holdings Advisory Service Staff (Rs. 10,392.88). Of the latter amount a sum of Rs. 6,427.65 had since been recovered.

(3) Nett Sale Average (Estate Working Account)

The nett sale average of St. Coombs teas was requested.

Reported that the nett sale price for all the teas including sales and free issues on St. Coombs was Rs. 2.82 per lb. The figure of Rs. 3.08 per lb. shown in the Accounts represented the nett sale price of teas sold in Colombo.

(4) Buildings: Research Capital Expenditure

In reply to an enquiry from Mr Coultas regarding the position of this vote, it was pointed out that all unspent balances were credited to the General Fund at the end of the year after the accounts were closed, and there was no provision for the creation of Suspense Accounts, or for re-voting of unspent balances. The estimate for capital expenditure on buildings was based on previous unfinished commitments and estimated current expenditure. The Chief Administrative Officer stated that the question of preparation of estimates was being referred to the Administrative Committee.

The Accounts of the Institute as at 31st July, 1959, were accordingly approved and adopted.

(b) Audited Accounts of the Institute, including Accounts of Estate, as at 31st December, 1958, and Auditor's Report for the year ending 31-12-58.

Reported that the Audited Accounts for the Institute as at 31st December, 1958, and the Auditors' Report thereon, together with the report on St. Coombs Estate, and the audited accounts of the T.R.I. Junior Staff Provident Fund and Medical Fund had been circularised as Circular No. A.34/59 of 22nd July, 1959, and were discussed in detail by the Administrative Committee at its meeting of 31st July, 1959.

Town Survey.—Reported that the estimated expenditure incurred for the Town Survey had been approved by the Administrative Committee and the Board. The details were submitted to Mr J. L. D. Peiris.

After some discussion the audited accounts of the Institute including the Accounts of the Estate as at 31st December, 1958, and the Auditors' Report for the year ending 31st December, 1958, were accordingly adopted. The comments of the Administrative Committee were noted, and the Committee's recommendations on issues raised by the auditors were approved.

6. Minutes of the Meeting of the Appointments Committee held on 5th June, 11th July and 18th July, 1959

The recommendations of the Appointments Committee were approved, and the minutes of the meetings of the 5th June, 11th July, and 18th July, 1959, were noted.

7. Minutes of the Meetings of the Administrative Committee held on 18th June, 31st July and 15th August, 1959

(a) Minutes of 18th June, 1959

(i) Page 6—Item 9 (3)—Supply of Clonal Leaf to Neuchatel Estate

A letter dated 28-8-59 received from Messrs Aitken Spence & Co., Ltd. regarding the sale of clonal leaf to Neuchatel Estate was read.

The Director explained the various difficulties involved in running this station and, as Mutwagalla was in the same region, it could be used instead as a clonal proving station, so that the Neuchatel land could be handed back to the owners.

The Board agreed.

(b) Minutes of 31st July, 1959

Page 7—Item 4 (*c*)—Administration of the Institute's Funds

On the proposal of Mr Mahadeva, seconded by Mr Coultas, the Board approved the following resolution:—

'Resolved that all cheques and/or other orders drawn upon the Institute's accounts including the accounts of the Junior Staff Provident Fund and Junior Staff Medical Fund shall be signed by any two of the following officers: The Chairman, the Director, the Chief Administrative Officer, as Secretary of the Board of Control, and the Administrative Secretary.

That Bills of Exchange and other negotiable instruments shall be drawn or accepted for and on behalf of the Institute by any two of the following officers: The Chairman, the Director, the Chief Administrative Officer, as Secretary of the Board of Control, and the Administrative Secretary.

That all cheques and other instruments requiring the endorsement of the Institute may be endorsed for and on behalf of the Institute by any one of the following officers: The Chairman, or the Director, or the Chief Administrative Officer, as Secretary of the Board of Control, or the Administrative Secretary.

That where two signatories are required the first signatory shall be the Administrative Secretary, and the counter signatories shall be the Chief Administrative Officer, or in his absence, the Director, or in the absence of the Director, the Chairman; provided that, in the absence of the Administrative Secretary, the Chief Administrative Officer shall be the first signatory and the document shall be countersigned by the Director, or in his absence the Chairman, and in the absence of the Administrative Secretary and the Chief Administrative Officer, the Director shall be the first signatory and the document shall be countersigned by the Chairman.'

The Chief Administrative Officer was directed to forward to the Bank a sealed copy of the resolution signed by the Chairman and Secretary, Board of Control, together with specimen signatures of the Chairman, Director, the Chief Administrative Officer and the Administrative Secretary.

(c) **Minutes of 15th August, 1959—Draft Estimates**

Item 2 (12), Sub-paragraph (2)—Over-expenditure

Mr Macintyre stated that he understood that the Director was authorised to sanction special expenditure in the circumstances stated when the matter was urgent and there was no time to refer to the Administrative Committee. It was felt that, with the frequent meetings of this Committee, there would be few cases where prior sanction from the Administrative Committee could not be obtained. Agreed that the minute be amended to include this proviso.

(2) Page 6—Item (5) (*a*)—Institute Insurances

The Board approved the principle of transferring the Institute's Insurances to Ceylonese Companies.

(3) Page 7—Item 5 (*b*)—Institute's Bank Accounts

Mr J. L. D. Peiris moved that the Institute's Bankers should be the National Institution, *viz.* the Bank of Ceylon. His views on the subject were contained in the minute under reference and he would emphasize that the Institute should support national Institutions.

After a full discussion Mr Peiris proposed that the current accounts of the Institute be transferred to the Bank of Ceylon. Mr Errol Jayawickreme seconded. The motion was put to the vote. The motion was lost 6 voting for and 8 against.

(4) Page 9—Item 7 (3)—Passage Allowances—Mr J. A. H. Tolhurst

Mr Macintyre stated that Mr Tolhurst was allowed passage allowances up to a maximum of £165 each for himself and wife and the appropriate rates for 2 children on this basis according to the ages of the children, and that it was a

matter for the Board to consider whether the allowances should be restricted to two or more children.

Mr Macintyre proposed, seconded by Mr Sanders, that a passage allowance be allowed for a third child on the same basis and that the privilege be extended to all overseas senior scientific staff. The Board approved.

(5) Page 10—Item 8—Building Programme

Mr Coultas stated that Mr J. L. D. Peiris, the Architects and himself had examined the tenders for the new buildings at St. Coombs, and with the concurrence and advice of the Architects it had been decided to offer the tender to Messrs Brown & Company, Ltd., on the terms and conditions stated on page 10—Item 9 of the Administrative Committee minutes under consideration. The recommendations of the Administrative Committee were approved.

Subject to the amendments made the recommendations of the Administrative Committee were approved, and the Minutes of the meetings held on 18th June, 1st July and 15th August, 1959, were noted.

8. Minutes of the Low-Country Sub-Station Committee held on 26th June and 11th August, 1959

Minutes of 11th August

(1) Page 1—Item 3—Superintendent

The Director reported that the conditions of service of Mr Galloway were circulated as Circular A.47/59 dated 1st September. These terms and conditions were personal to Mr Galloway. Approved.

(2) Page 2—Item 6—Staff

The Chairman read a letter from the Director dated 28th July, 1959, giving notice of his resignation from the service of the Institute as from January, 1960. He said that this letter had been considered at the Low-Country Sub-Station Committee meeting held on the 11th August, 1959, and as reported in the minutes the Director had kindly agreed to reconsider the matter, and was prepared to continue till the work of establishment of the station was completed, provided his health permitted.

Mr Mahadeva felt that it was very desirable that the Director should continue if his health permitted him to do so.

Mr Macintyre moved that the Board's thanks to Dr Joachim be recorded for agreeing to continue in service, but that he did not wish him to endanger his health.

(3) Bungalows for Staff

In reply to a question as to whether the scientific staff agreed to the conversion of the rubber factory into a laboratory building, the Director said he had consulted the staff regarding the plans for the laboratory and that they had made certain suggestions. The plans were not finalised and he hoped to take some of the staff to Mutwagalla and explain the position to them. The laboratories were not being planned on an elaborate scale as they were intended to be essentially field laboratories. The machinery to be introduced was the experimental machinery of the type used at St. Coombs.

Subject to the amendments made, the recommendations of the Low-Country Committee were approved and the minutes of the meetings of 26th June and 14th August, 1959, were noted.

9. Minutes of the Meeting of the Experimental and Estate Committee held on 1st August, 1959

Page 1—Item 4 (i)—Instant Tea

A memorandum dated 13th August, and Mr Sanders' letter dated 20th August, 1959, were considered.

After discussion on the various aspects of the development of the project it was agreed that:—

(1) As full a report as possible furnishing the details of the investigations carried out and the results obtained up to date with an appraisal of the position in regard to further developments be obtained from the Ceylon Institute of Scientific and Industrial Research, and referred to the Scientific Advisory Committee in the United Kingdom for their opinion and advice as to what further action would be needed; and to Dr Gunn for his consideration and consultation with the Advisory Committee.

(2) The report when referred back to the Board to contain an estimated cost of the equipment that would be required for manufacture on a pilot scale.

(3) A top-grade Biochemist be appointed as early as possible, the post to be advertised as usual both locally and abroad.

Tea Replanting

The Director reported that the Tea Subsidy Board at its meeting held the previous day, approved the resolution of the Experimental and Estate Committee that rehabilitation for a minimum period of one year should be made compulsory before replanting. Special application would have to be made for an exemption from this rule.

Mr Mahadeva indicated that the circular would state that the Tea Research Institute strongly recommended this proposal with which the Advisory Board agrees.

Biological Control of Mites

The Director commented briefly on the visit of Dr Simmonds, Director of the Commonwealth Institute of Biological Control, to the Institute, who had suggested that the Institute should contribute a small sum towards a co-operative scheme for the biological control of mites with the Commonwealth Institute of Biological Control which had a sub-station in India. The Experimental and Estate Committee recommended a grant of £500. It was not an annual subscription, but a special grant for a special investigation in which the Institute was interested. The expenditure was approved.

In reply to a question from Mr Sanders the Director said that it was a rule that the economic needs of the estate should not take priority over experimental work.

10. Study Groups

Mr Sanders suggested the Institute should have study groups on estates so that the Scientific Staff could get together with superintendents and others. He was referring to study groups in the field in various districts.

Agreed that the proposal be referred to the Experimental and Estate Committee.

11. Staff Matters

1. Senior Staff

Reported that Dr M. T. Hutchinson had assumed duties as Consultant Nematologist on 26th August, 1959.

2. Junior Staff

Reported that Mr L. S. Weragoda had been appointed Junior Technical Assistant, Grade IIA, in Technology for Low-Country Sub-Station as from 1st August. The report was received.

12. Other Business

(1) Dr A. W. R. Joachim

The Chairman, on behalf of the Board, thanked Dr Joachim who would be relinquishing the post of Director at the end of September, for the services he had rendered to the Board and the Institute during the short period he served as Director. He said that when Dr Joachim took over the Directorship the Institute was short of most of the Senior Scientific Staff and with his able assistance and that of Dr Tubbs the Institute had been able to fill practically all the posts except that of Plant Breeder. On behalf of the Board he moved a vote of appreciation of the work Dr Joachim had done. He thanked him personally as Chairman of the Board for the great assistance he had given him. He wished Dr & Mrs Joachim all the best.

Dr Joachim thanked the Chairman and the Board for their kind sentiments.

(2) Administrative Committee

Mr Coultas raised the question of the implementation of the decisions of the Administrative Committee and said that till the Board approved the Committee's recommendations no action could be taken. This meant a delay of three months; he enquired whether the Board could not empower the Administrative Committee to act in matters within its jurisdiction pending approval of the Board. This applied chiefly to financial commitments not provided for in the estimates, and he would suggest that the Committee be empowered to spend up to a lakh.

The Chief Administrative Officer said that the whole question of the functions and powers of the Administrative Committee had to be considered as the present procedure resulted in administrative delays even in routine matters.

Mr C. D. Green suggested that any urgent matters could be circulated to the Board for its approval.

Agreed that the Administrative Committee discuss the question of special powers and report to the Board.

Next Meeting. –The next meeting was fixed for Friday, 4th December.

Sgd H. J. BALMOND,
Secretary,
Board of Control.

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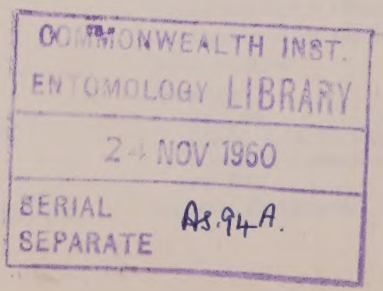
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